Amendments To The Claims

Please cancel Claims 16 and 32-45 without prejudice. The following list of the claims replaces all prior versions and lists of the claims in this application.

1. (Currently amended) A method of forming a low-k dielectric material layer, comprising the steps of:

forming a first dielectric material sub-layer over a substrate;

treating the first dielectric material sub-layer with an energy treatment to form a hardened layer on the upper surface of the first dielectric material sub-layer; and

forming a second dielectric material sub-layer over the hardened layer;

wherein the first dielectric material sub-layer, the hardened layer and the second dielectric material sub-layer comprise the low-k dielectric material layer.

2. (Original) The method of claim 1, wherein the first dielectric material sub-layer is comprised of SiOC.

3. (Original) The method of claim 1, wherein the first dielectric material sub-layer has a dielectric constant of from about 2.3 to 2.6.

4. (Original) The method of claim 1, wherein the first dielectric material sub-layer has a dielectric constant of greater than about 2.8.

5. (Original) The method of claim 1, wherein the hardened layer has a thickness of from about 250 to 500Å.

6. (Currently amended) The method of claim 1, wherein the hardened ~~layers~~ layer has a thickness of from about 300 to 450Å.

7. (Original) The method of claim 1, wherein the energy treatment is conducted in situ.

8. (Original) The method of claim 1, wherein the energy treatment is conducted ex situ.

9. (Original) The method of claim 1, wherein the energy treatment is conducted using H_2.

10. (Original) The method of claim 1, wherein the energy treatment is conducted under the following conditions:

H_2 flow: from about 1600 to 2400 sccm;

temperature: from about 300 to 450°C;

pressure: from about 4.5 to 9.0m Torr;

time: from about 30 to 240 seconds; and

power: from about 300 to 1500 W.

11. (Original) The method of claim 1, wherein the energy treatment is conducted under the following conditions:

H_2 flow: from about 1800 to 2200 sccm;

temperature: from about 350 to 400°C;

pressure: from about 6.0 to 7.5 mTorr;

time: from about 90 to 180 seconds; and

power: from about 600 to 1200 W.

12. (Original) The method of claim 1, wherein the hardened layer is an etch stop layer.

13. (Original) The method of claim 1, including the steps of:

patterning the second dielectric material sub-layer, the hardened layer and the first dielectric material sub-layer to form a via opening exposing a portion of the substrate; and

then, using the hardened layer as an etch stop layer, patterning the second dielectric material sub-layer to form a trench opening over the via opening and exposing portions of the hardened layer.

14. (Original) The method of claim 1, including the steps of:

patterning the second dielectric material sub-layer, the hardened layer and the first dielectric material sub-layer to form a via opening exposing a portion of the substrate; and

then, using the hardened layer as an etch stop layer, patterning the second dielectric material sub-layer to form a trench opening over the via opening and exposing portions of the hardened layer;

the trench opening and the via opening comprising a dual damascene opening.

15. (Original) The method of claim 1, including the steps of:

patterning the second dielectric material sub-layer, the hardened layer and the first dielectric material sub-layer using an overlying first patterned mask layer to form a via opening exposing a portion of the substrate; and

then, using the hardened layer as an etch stop layer, patterning the second dielectric material sub-layer using an overlying second patterned mask layer to form a trench opening over the via opening and exposing portions of the hardened layer.

16. (Canceled).

17. (Currently amended) The method of claim ~~16~~ 27, wherein the sequentially formed one or more dielectric material sub-layers are each comprised of SiOC.

18. (Currently amended) The method of claim ~~16~~ 27, wherein the sequentially formed one or more dielectric material sub-layers each have a dielectric constant of from about 2.3 to 2.6.

19. (Currently amended) The method of claim ~~16~~ 27, wherein the sequentially formed one or more dielectric material sub-layers each have a dielectric constant of greater than about 2.8.

20. (Currently amended) The method of claim ~~16~~ 27, wherein each of the respective hard layers has a thickness of from about 250 to 500Å.

21. (Currently amended) The method of claim ~~16~~ 27, wherein each of the respective hard layers has a thickness of from about 300 to 450Å.

22. (Currently amended) The method of claim ~~16~~ 27, wherein the one or more respective hydrogen treatments are conducted in situ.

23. (Currently amended) The method of claim ~~16~~ 27, wherein the one or more respective hydrogen treatments are conducted ex situ.

24. (Currently amended) The method of claim ~~16~~ 27, wherein the one or more respective hydrogen treatments are conducted using H_2.

25. (Currently amended) The method of claim ~~16~~ 27, wherein the one or more respective hydrogen treatments are conducted under the following conditions:

H_2 flow: from about 1600 to 2400 sccm;

temperature: from about 300 to 450°C;

pressure: from about 4.5 to 9.0 mTorr;

time: from about 30 to 240 seconds; and

power: from about 300 to 1500 W.

26. (Currently amended) The method of claim ~~16~~ 27, wherein the one or more respective hydrogen treatments are conducted under the following conditions:

H_2 flow: from about 1800 to 2200 sccm;

temperature: from about 350 to 400°C;

pressure: from about 6.0 to 7.5 mTorr;

time: from about 90 to 180 seconds; and

power: from about 600 to 1200 W.

27. (Currently amended) ~~The method of claim of claim 16,~~ A method of forming a dielectric material layer, comprising the steps of:

sequentially forming one or more dielectric material sub-layers over a structure;

treating each sequentially formed one or more dielectric material sub-layers in sequence with a respective hydrogen treatment to form respective hard layers on the upper surface of each respective sequentially formed one or more dielectric material sub-layers; and

forming an uppermost dielectric material sub-layer over the sequentially formed one or more dielectric material sub-layers and respective hard layers to complete formation of the dielectric material layer;

wherein the one or more of the respective hard layers are etch stop layers.

28. (Currently amended) The method of claim ~~16~~ 27, wherein there is one dielectric material sub-layer having a hard layer formed thereover by the respective hydrogen treatment.

29. (Currently amended) The method of claim ~~16~~ 27, wherein there is one dielectric material sub-layer having a hard layer formed thereover by the respective hydrogen treatment; and including the steps of:

patterning the uppermost dielectric material sub-layer, the hard layer and the one dielectric material sub-layer to form a via opening exposing a portion of the structure; and

then, using the hard layer as an etch stop layer, patterning the uppermost dielectric material sub-layer to form a trench opening over the via opening and exposing portions of the hard layer.

30. (Currently amended) The method of claim ~~16~~ 27, wherein there is one dielectric material sub-layer having a hard layer formed thereover by the respective hydrogen treatment; and including the steps of:

patterning the uppermost dielectric material sub-layer, the hard layer and the one dielectric material sub-layer to form a via opening exposing a portion of the structure; and

then, using the hard layer as an etch stop layer, patterning the uppermost dielectric material sub-layer to form a trench opening over the via opening and exposing portions of the hard layer;

the trench opening and the via opening comprising a dual damascene opening.

31. (Currently amended) The method of claim ~~16~~ 27, wherein there is one dielectric material sub-layer having a hard layer formed thereover by the respective hydrogen treatment; and including the steps of:

patterning the uppermost dielectric material sub-layer, the hard layer and the one dielectric material sub-layer using an overlying first patterned mask layer to form a via opening exposing a portion of the structure; and

then, using the hard layer as an etch stop layer, patterning the uppermost dielectric material sub-layer using an overlying second patterned mask layer 30 to form a trench opening over the via opening and exposing portions of the hard layer.

Claims 32-45 (Canceled).